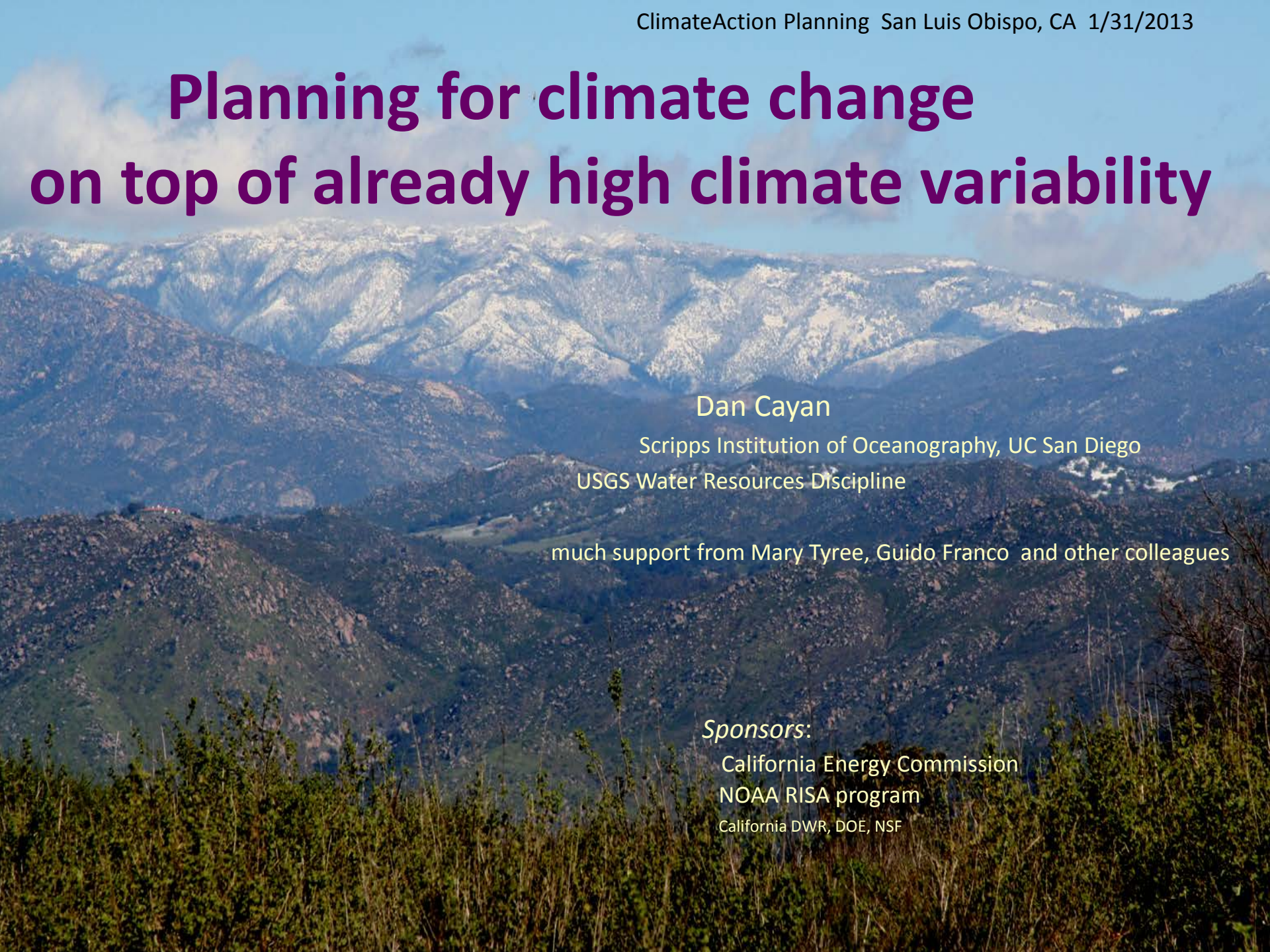
Planning for climate change on top of already high climate variability



Dan Cayan

Scripps Institution of Oceanography, UC San Diego

USGS Water Resources Discipline

much support from Mary Tyree, Guido Franco and other colleagues

Sponsors:

California Energy Commission

NOAA RISA program

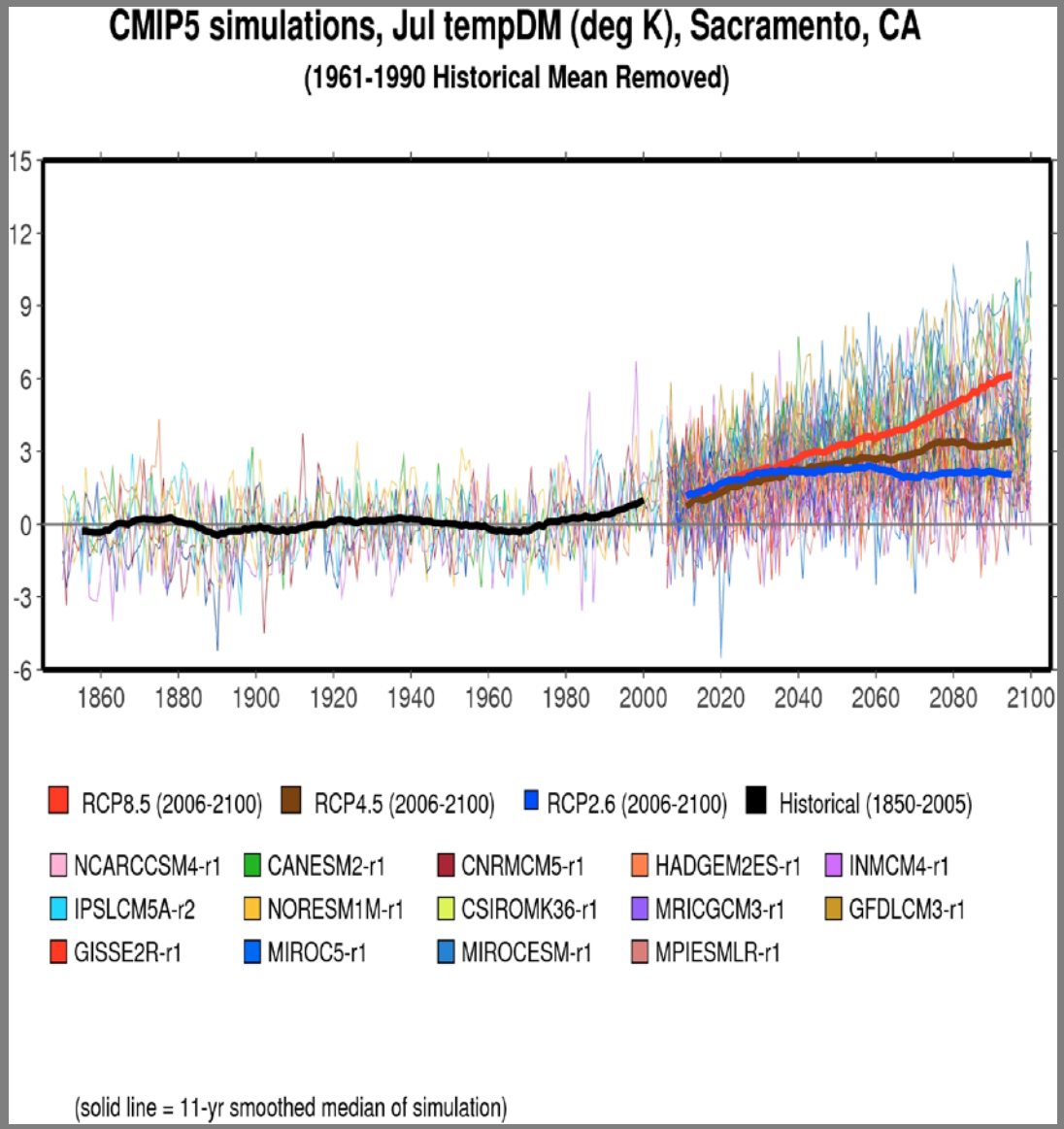
California DWR, DOE, NSF

Uncertainty is substantial in climate projections

Temperature Change

14 GCMs X 3 RCP emissions Scenarios

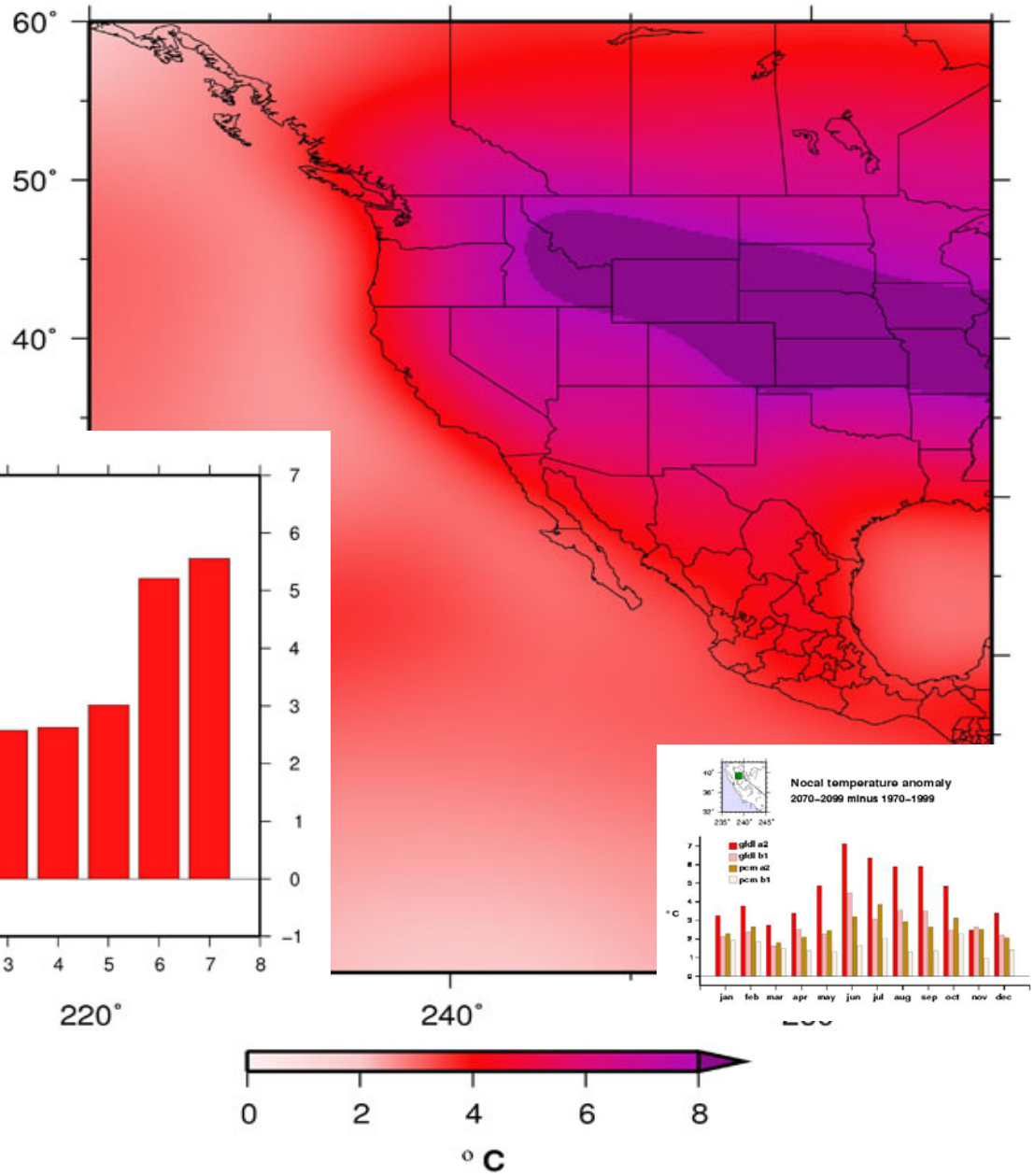
IPCC 5th Assessment (CMIP5) models

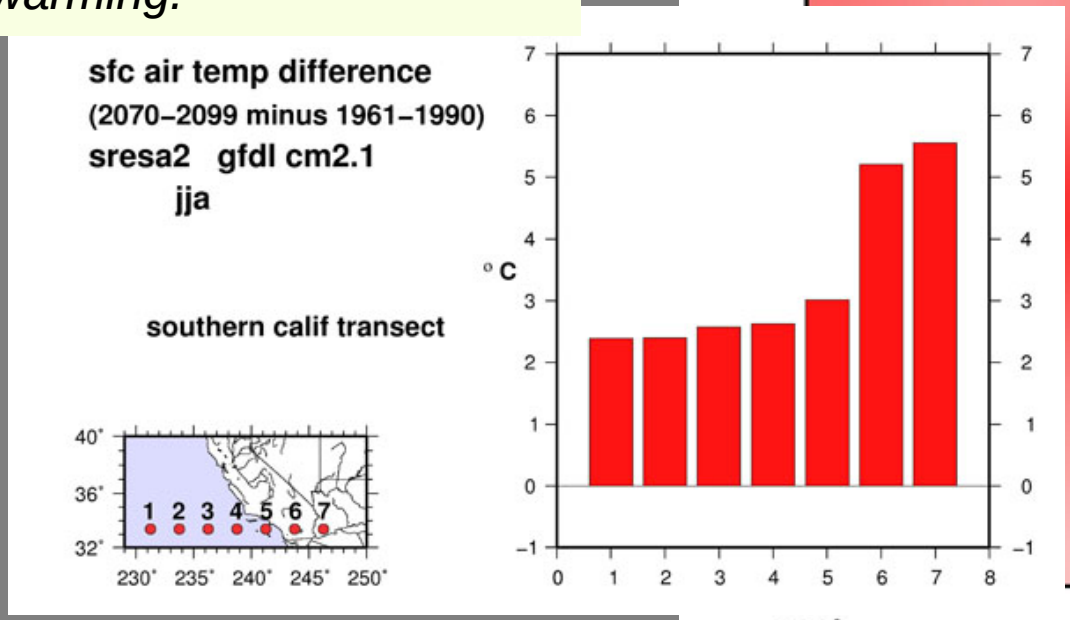


Climate models project ocean warming by end of century of 1.5-2.C greater warming on land than oceans would amplify thermal gradient across California coast-interior

Some models produce accentuated summer land warming.

GFDL CM2.1 Jun-Aug air temp change
2070-2099 minus 1961-1990



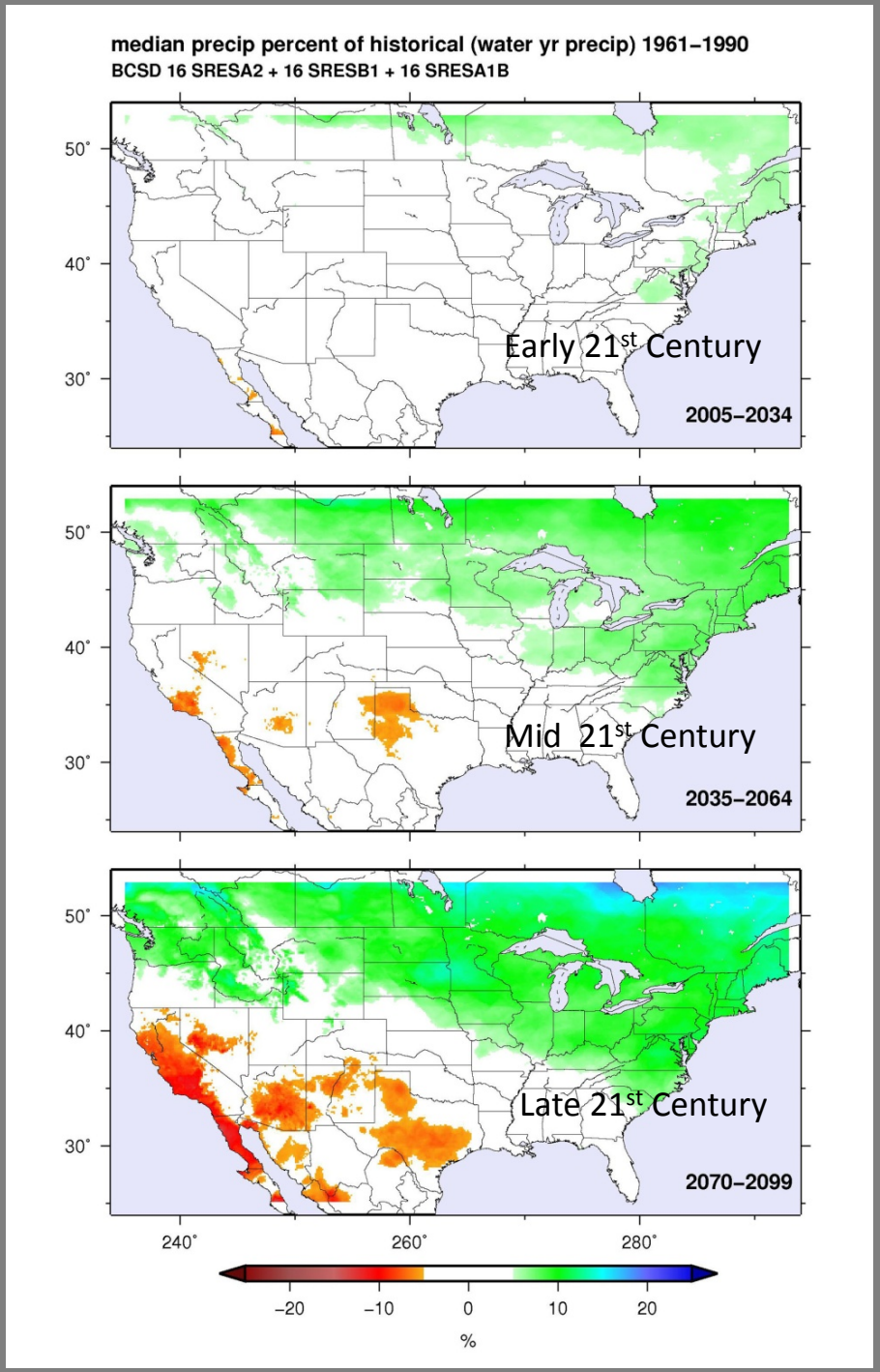


Projected Precipitation Change

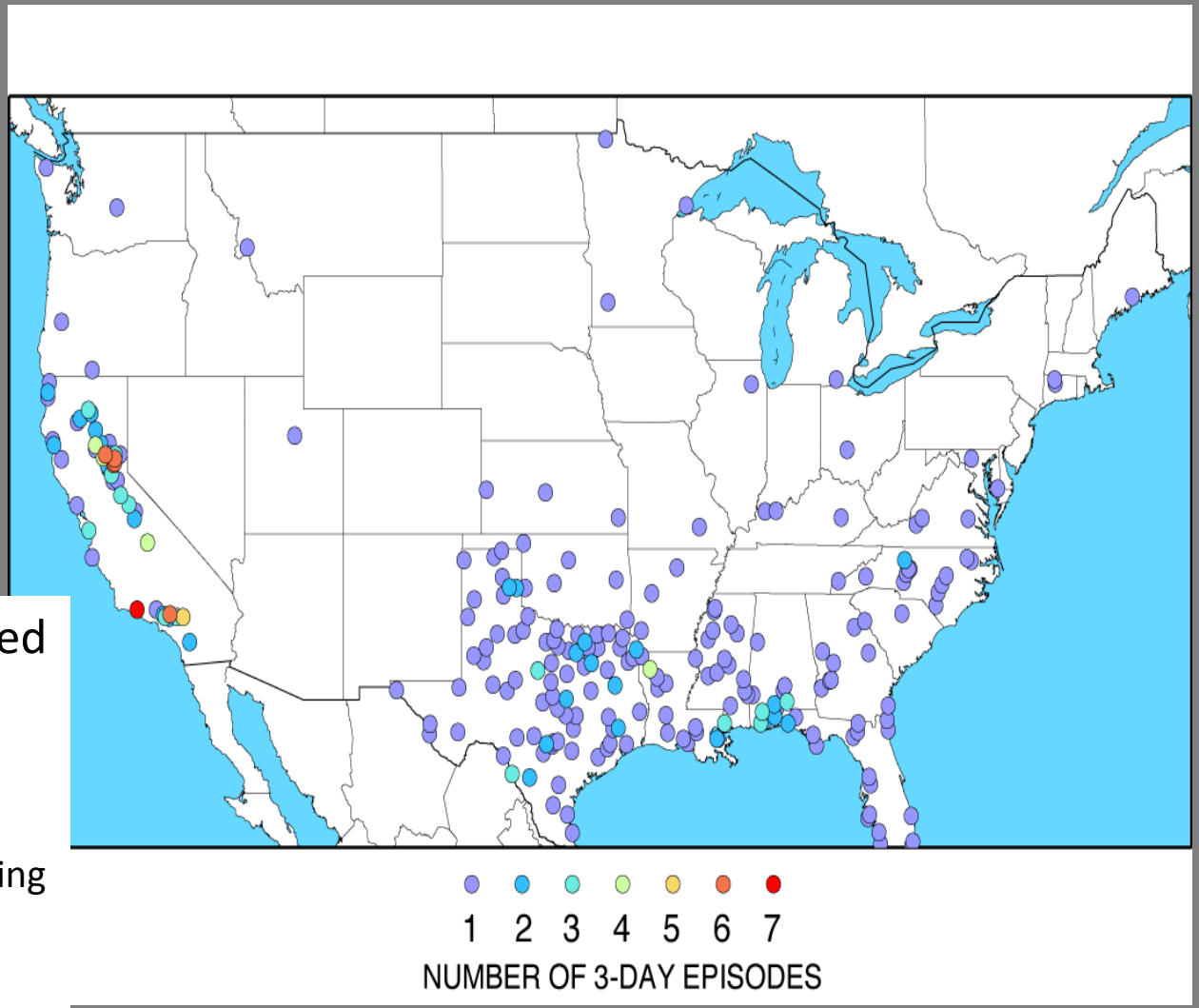
Incrementally drier Southwest, especially Southern California develops over the 21st Century.

Drying becomes greater as climate becomes warmer

from 48 climate model simulations downscaled to 12km using BCSD

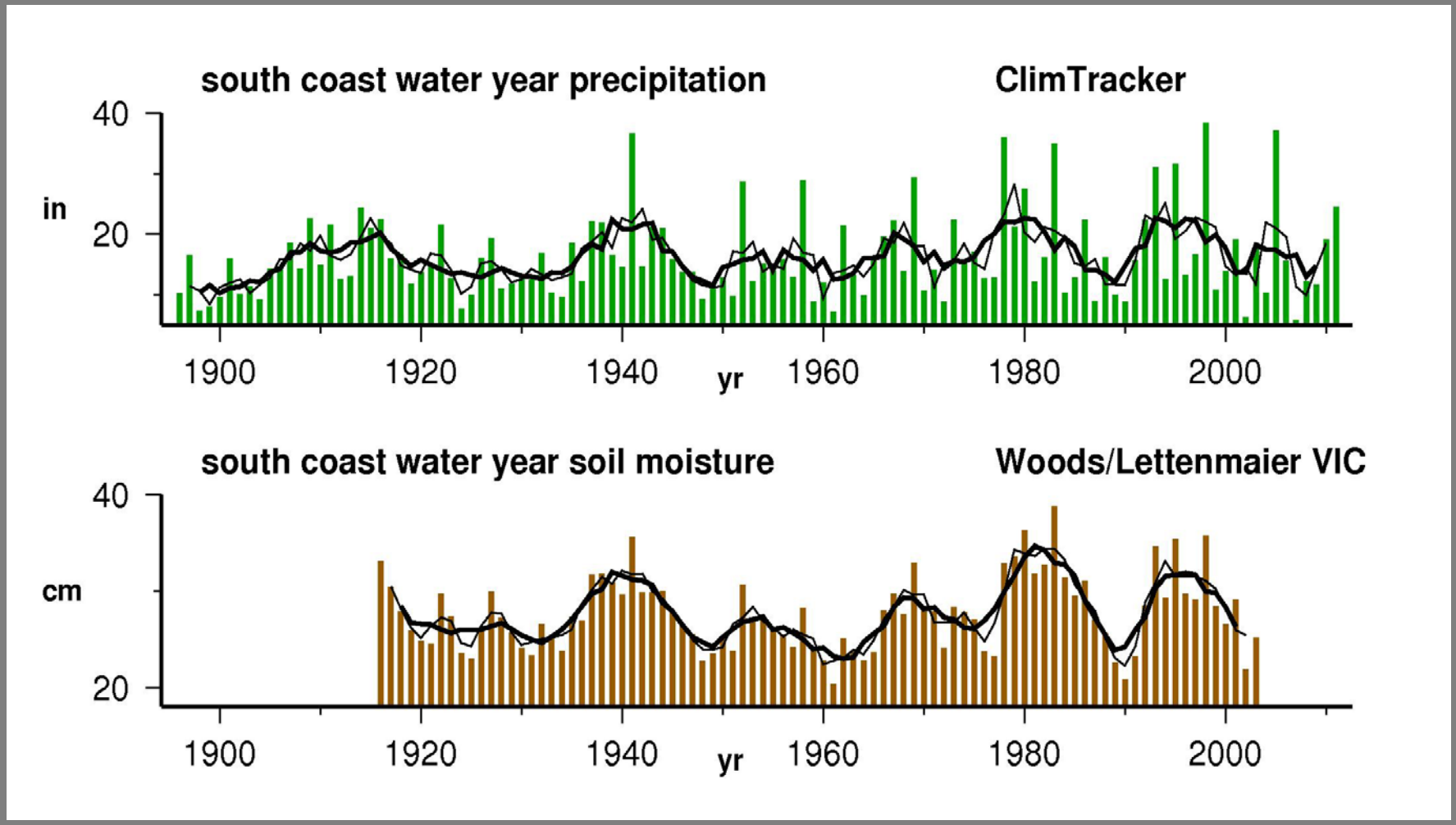


High variability of weather and short term climate will continue



Stations that have recorded the highest 3-day precipitation amounts

Numbers of non-overlapping 3-day precipitation totals at COOP weather stations that exceeded 40 cm (15.75”) from 1950-2008.



Great year-to-year variability of precipitation, San Diego

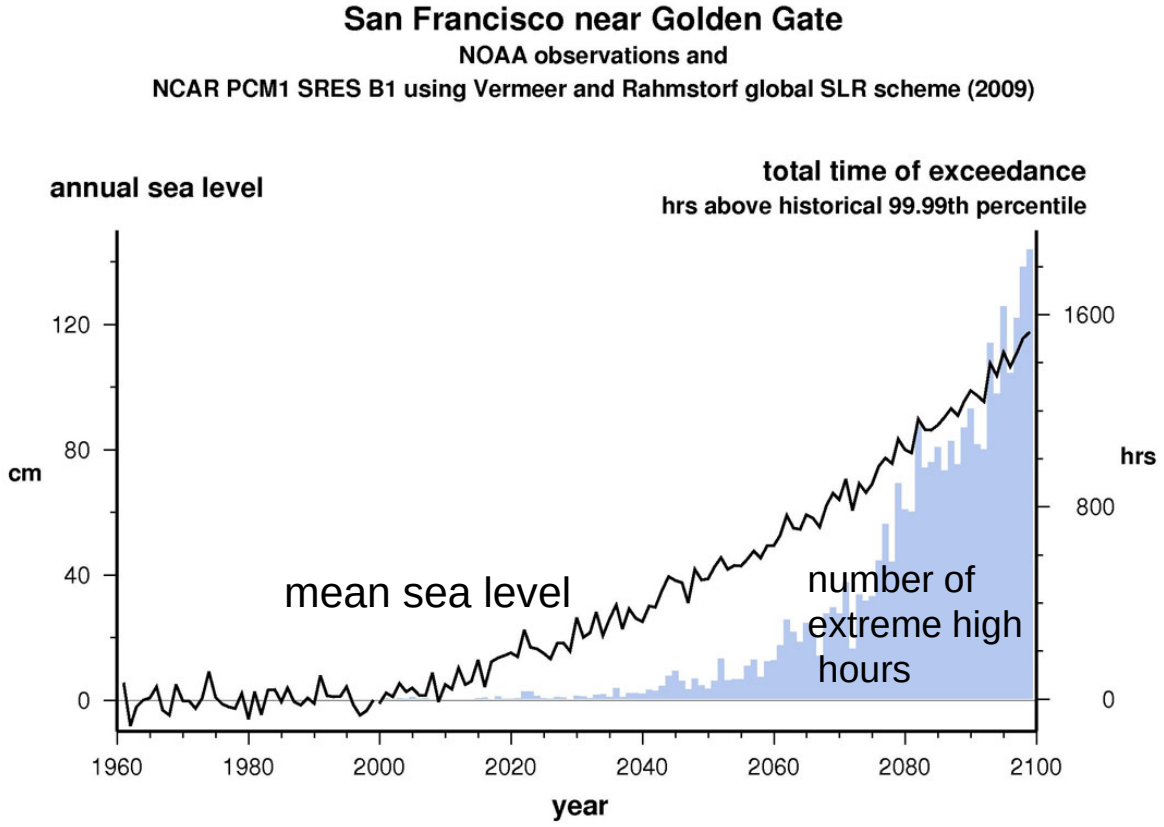
Ranges from ~20% to 280% of average

The *pace* of climate change is projected to be rapid

INCREASING SEA LEVEL EXTREMES

As mean sea level rises the frequency and magnitude of extremes would increase markedly. Under plausible rates of sea level rise, an event which in present day occurs less than once per year occurs scores of times per year by mid 21st Century and becomes commonplace by end of 21st Century.

Importantly the duration of extremes becomes longer, so exposure to waves is considerably greater.



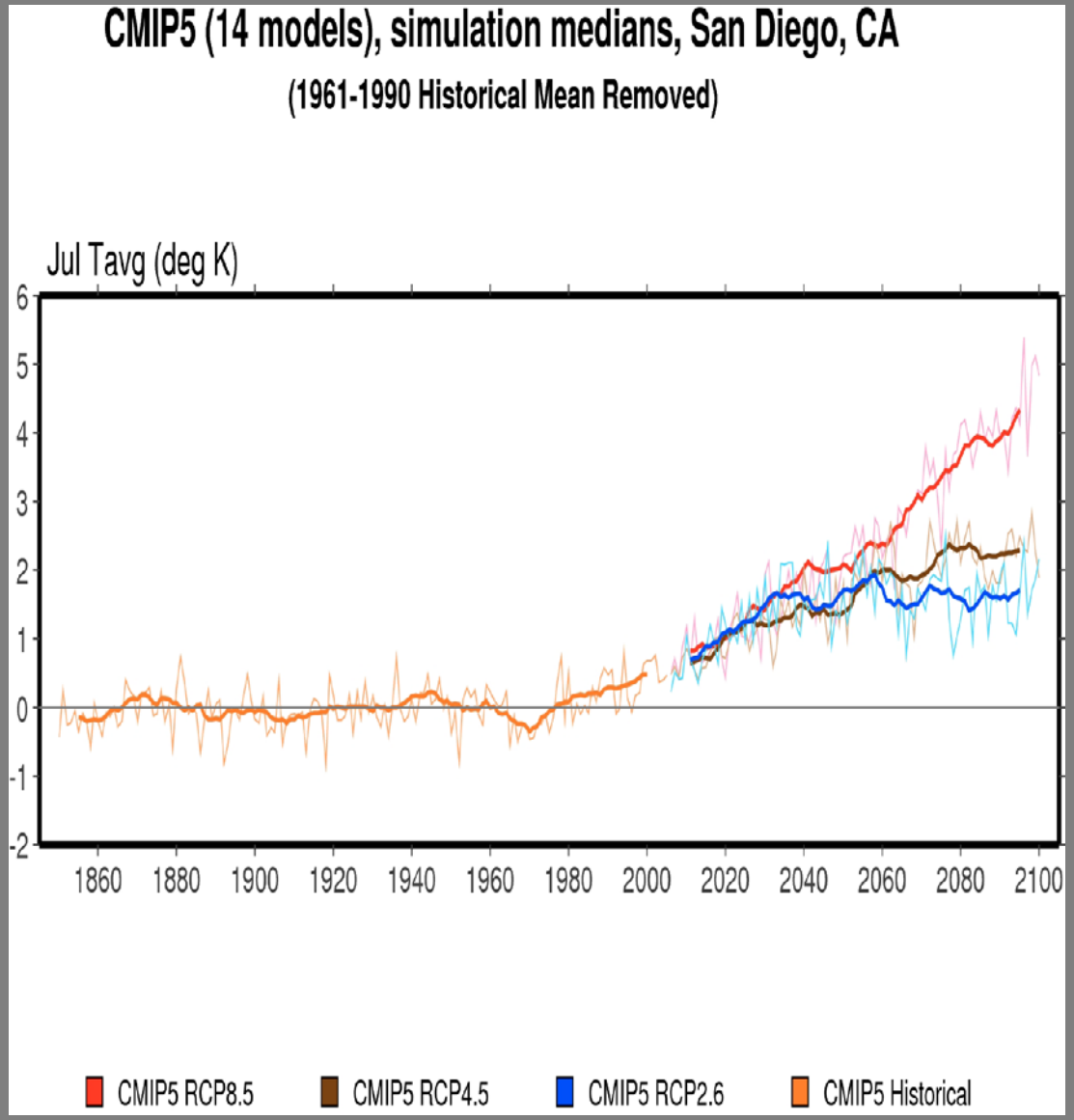
Median change

July Temperature

14 GCMs

3 RCP emissions Scenarios

IPCC 5th Assessment (CMIP5) models



global climate models have been downscaled across California

limited number of climate measures

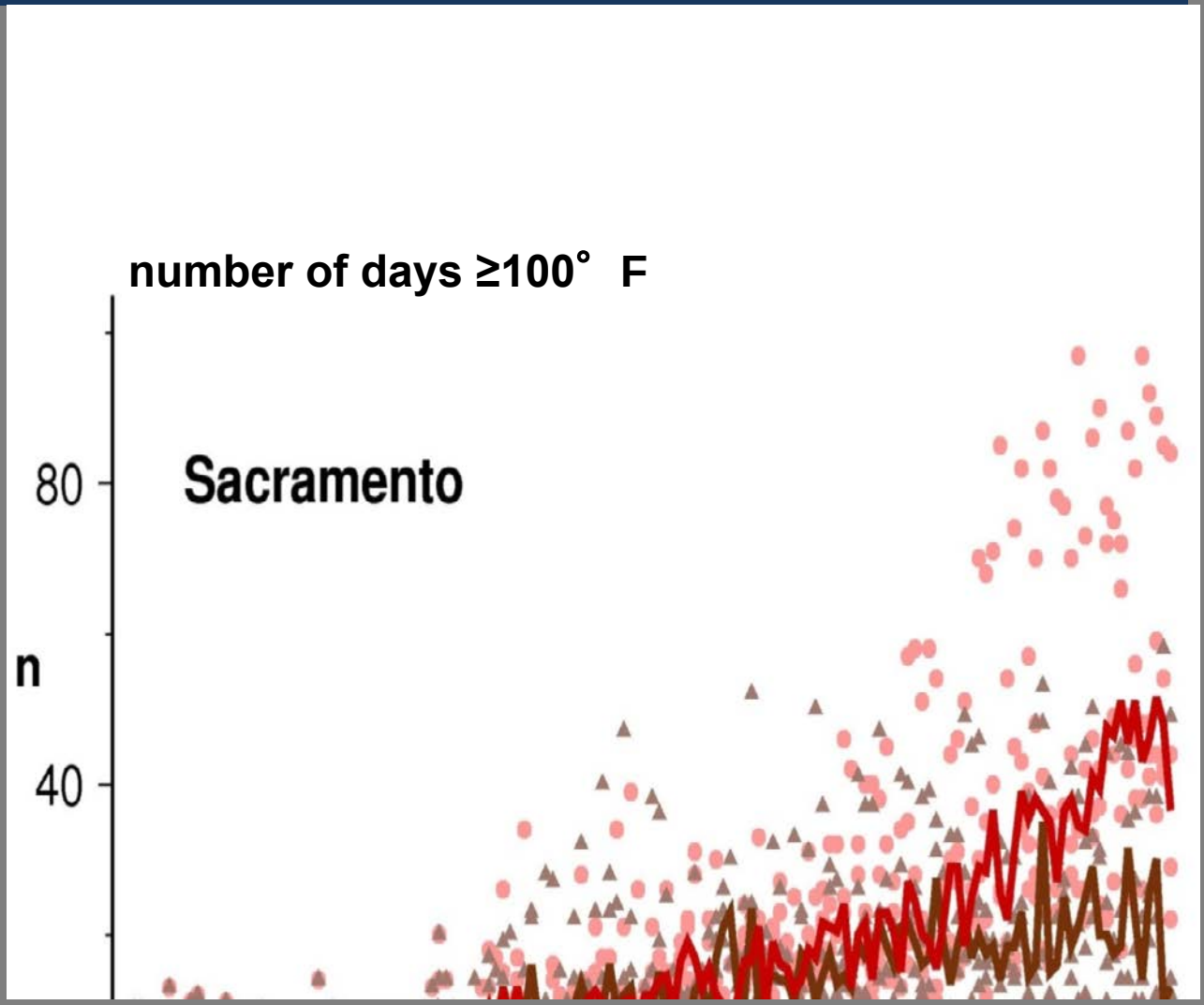
* having and sustaining local observational datasets is valuable
* understanding vulnerabilities is crucial

Heat Waves

Projected in Sacramento,

SRES A2 and SRES B1 GHG Emissions Scenarios

Number of Days (n), April–October, When Maximum Temperature (Tmax) Exceeds the 98th Percentile Historical (1961–1990) Level of 38°C (100.4°F) at Sacramento from Four BCCA Downscaled GCMs. Brown carrots and red dots shown for B1 and A2 emission scenarios, respectively. Thick brown (B1) and red (A2) lines show median value from the four simulations.



Global to regional downscaling

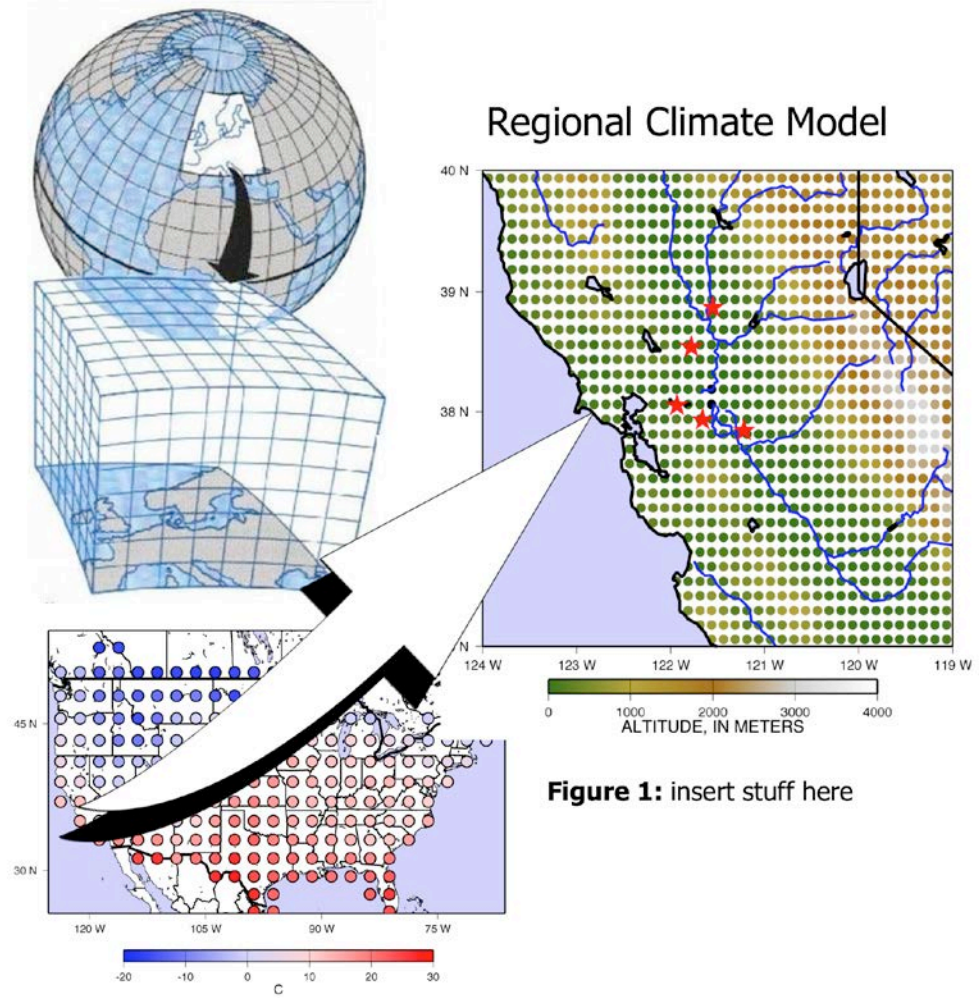


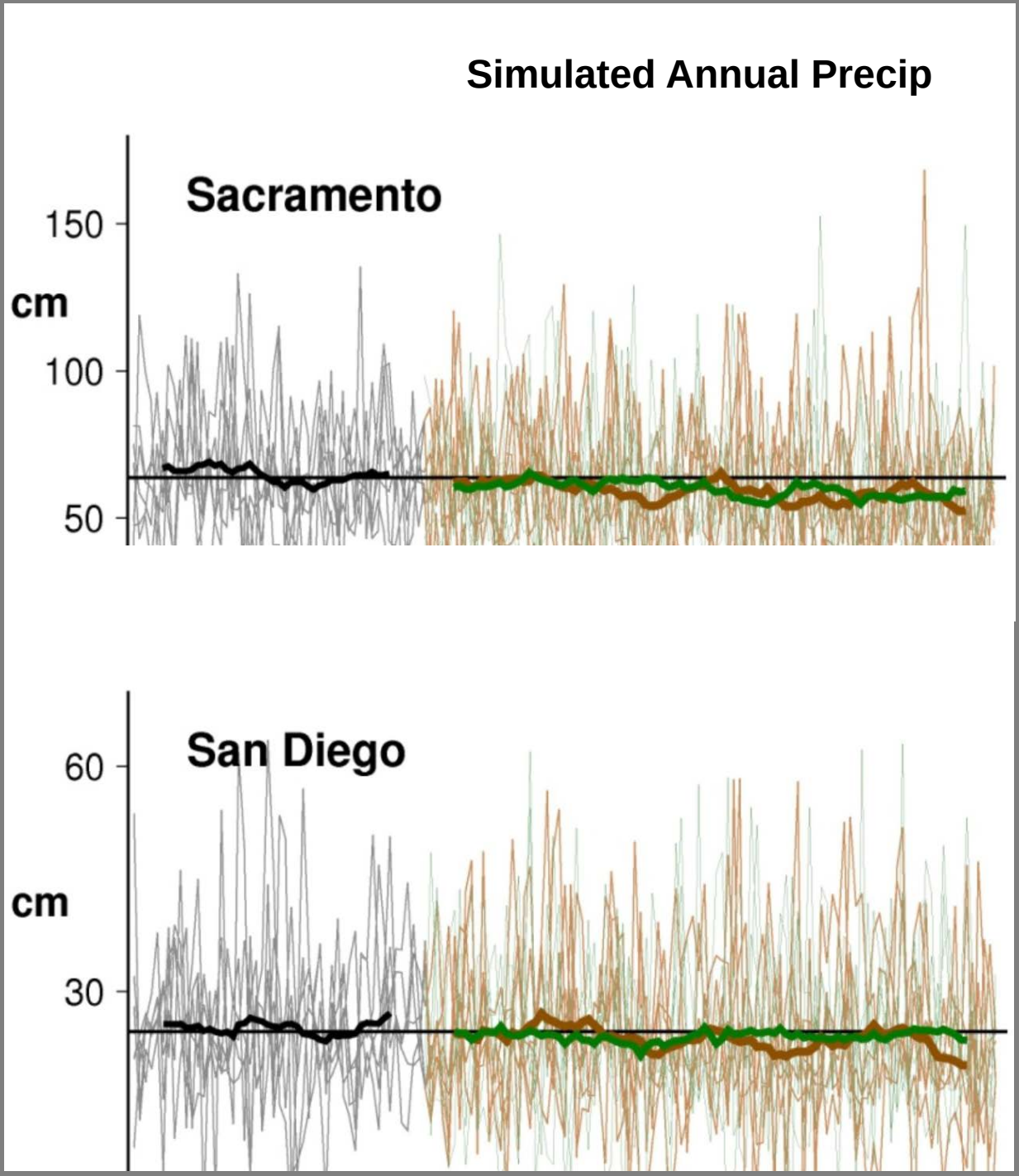
Figure 1: insert stuff here

GCMs ~150km downscaled to Regional models ~ 12km

Many simulations IPCC AR4 and IPCC AR5 have been downscaled using statistical methods

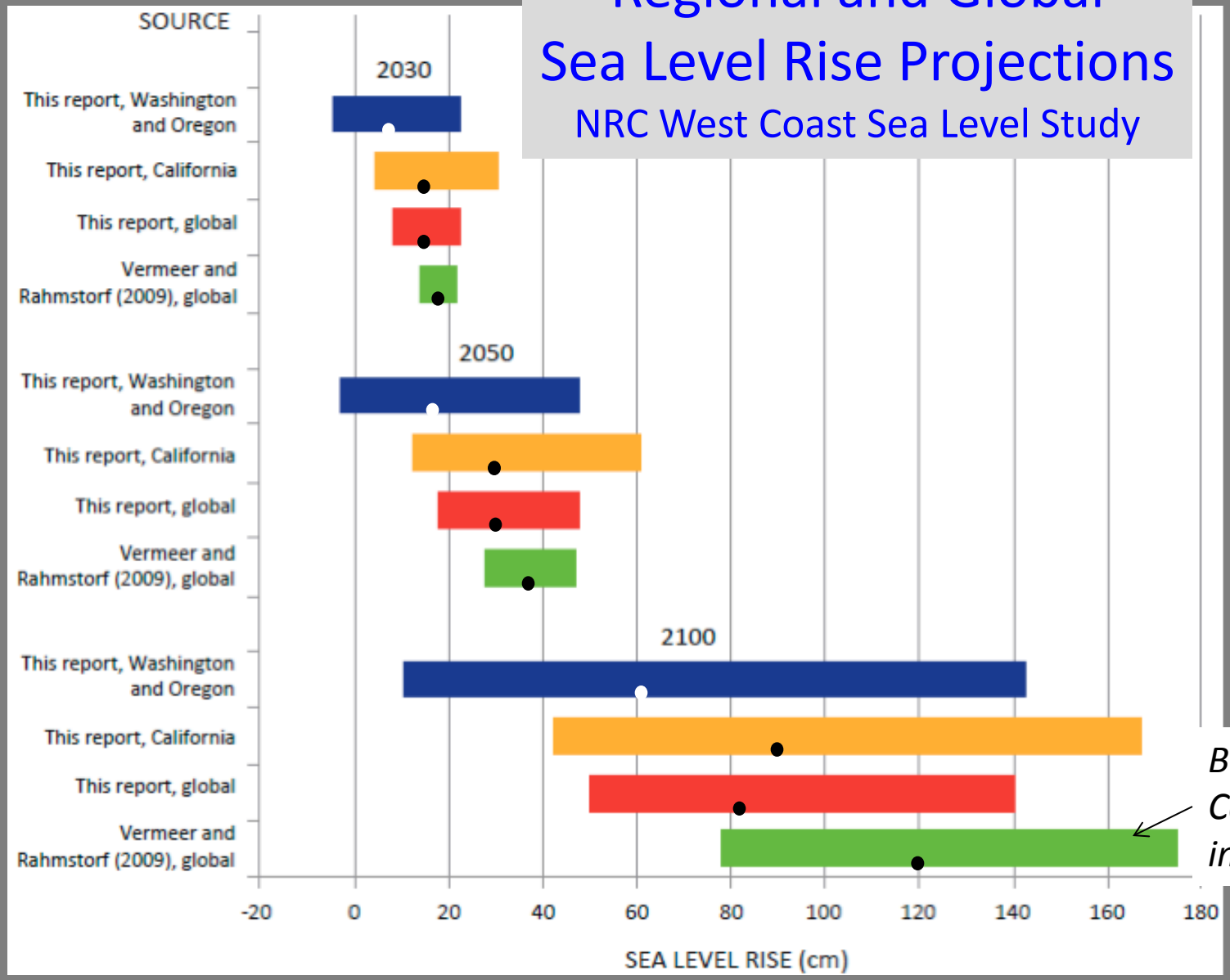
Simulated Annual Precip (cm), Sacramento and San Diego from Six GCM's for Historical and Projected Twenty-First Century for B1 and A2 Emission Scenarios. Thin black line shows the average precipitation simulated for 1961–1990. Thin green lines and brown lines show values from B1 and A2 simulations, respectively. Thick lines show 11-year running mean smoothed median of the six historical (black), B1 (green) and A2 (brown) simulations.

GCMs used are those used in the 2008 Califor Climate Assessment .



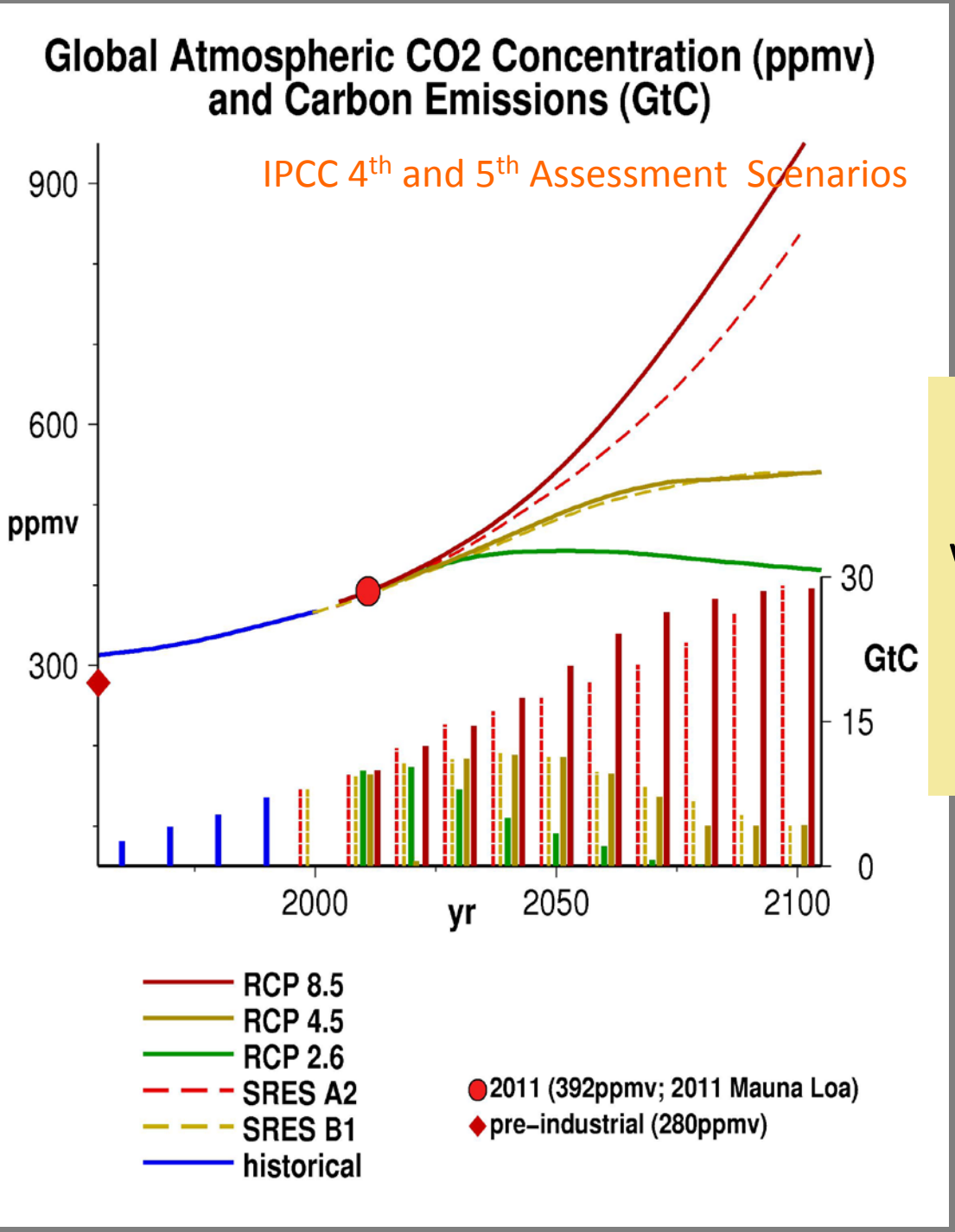
Regional and Global Sea Level Rise Projections

NRC West Coast Sea Level Study



Being used by California for interim planning

NRC West Coast SLR study 2012



different greenhouse gas emissions trajectories would have enormous impacts on climate in future decades